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Perspectives

Recovery Strategies from the OR to Home

Ventilator-Associated Pneumonia and Tracheostomy

CRCE's for Respiratory Therapists
CEUs for Nurses

Charles G. Durbin Jr, MD, FCCM, FAARC

ABSTRACT

Ventilator-associated pneumonia (VAP) is defined as a lower respiratory tract infection occurring at least 2 days after beginning mechanical ventilation. The estimated associated mortality rate is 24% to 50%. Because VAP is prevalent in ICU patients on mechanical ventilation, numerous studies have been undertaken to determine ways to decrease its incidence. One area of study surrounds the utility of early tracheostomy as a deterrent to VAP. The association of tracheostomy with VAP, the benefits of an early tracesotomy is the purpose of Dr. Durbin's review.

tracheostomy is an intensive-care measure that requires specialized care and monitoring. Despite its potential for reducing ventilator-associated pneumonia, it has its own risks, which are minimized by careful attention to device and patient care. In this issue of Perspectives, we have assembled a panel of experts to discuss trach care, strategies to minimize morbidity and mortality in this patient population, patient and family education, and decisions regarding weaning and decannulation. Differences in adult versus pediatric populations are also highlighted.

Ventilator-associated pneumonia (VAP) is defined as a lower respiratory tract infection occurring at least 2 days after beginning mechanical ventilation. While VAP is named for its association with mechanical ventilation, it is believed to be caused by oral or nasotracheal intubation and only coincidently related to mechanical ventilation. VAP is considered to be clinically significant with an estimated associated mortality rate of 24% to 50%.[1] In addition to increasing the likelihood of death in the ICU or hospital,[2] VAP survivors have a reduced life expectancy after hospital discharge. For example, a study by Ranes revealed that 25.9% of survivors of VAP were dead 1 year later, and 44.7% survived no more than 5 years.[3]

In a study from the Netherlands, 92% of all bacteriologically proven infections in the 2 ICUs studied occurred in intubated patients; 71% of those infections were deemed ICU-acquired.[4] Because VAP is prevalent in ICU patients on mechanical ventilation, numerous studies have been undertaken to determine ways to decrease its incidence. One area of study surrounds the utility of early tracheostomy as a deterrent to VAP.

Benefits of early tracheostomy cited in various studies include (1) shorter ICU and hospital stays, (2) lower incidence of VAP, and, in some cases, (3) decreased mortality and (4) shorter weaning times. However, these outcomes vary by study design and ICU patient population, making results difficult to interpret and apply. Studies of early tracheostomy must grapple with a great amount of heterogeneity, including (1) different patient populations, (2) presence of different underlying diseases or multi-organ damage that could confound results, (3) difficulties predicting which patients need to receive prolonged mechanical ventilation (≥ 14 days) (4) lack of a standard definition of "early" versus "late" tracheostomy or an optimal technique for doing the procedure, (5) institutional differences in diagnosing VAP, (6) differences in weaning methods, and (7) varying quality of study design and data collection.

Whether VAP contributes to increased risk of death remains debatable. However, we know unequivocally that VAP prolongs the duration of mechanical ventilation, lengthens the ICU stay, and increases healthcare consumption. One component of this is the direct cost of antimicrobial therapy, as antibiotic consumption is 10 times greater in ICUs than in general hospital care units.[4] A 2003 cost analysis by Warren and colleagues[5] showed that each case of VAP was associated with an additional direct cost of almost $12,000. Thus, prevention of VAP can positively affect clinical and financial outcomes.

The association of tracheostomy with VAP is the purpose of this review. Mechanical ventilation is known to be associated with infections, including local wound infections, VAP, and septicemia.[6] Because translaryngeal tubes provide a direct conduit to the lower airway and are often colonized with pathogenic organisms, replacing a translaryngeal tube with a tracheostomy removes the direct pathway from the mouth to the lung, potentially protecting the patient from VAP.

Etiology of VAP

Prevention of VAP requires understanding of how it develops. The prevailing theory is that bacteria from the mouth and upper respiratory tract gain entrance into the lower respiratory tract via the artificial airway.

Continued on page 4

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Panel Discussion: Care of Tracheostomy Tubes and Trach Patients

Moderator: *Charles Durbin, MD*
Panelists: *Tom Cahill BHS, RCP, RRT-NPS, EMT-P*
Cynthia White, RRT-NPS, AE-C, FAARC
David A. Grooms, MSHS, RRT

Tracheostomy is an intensive-care measure that requires specialized care and monitoring. Despite its potential for reducing ventilator-associated pneumonia, it has its own risks, which are minimized by careful attention to device and patient care. The following discussion covers trach care, strategies to minimize morbidity and mortality in this patient population, patient and family education, and decisions regarding weaning and decannulation. Differences in adult versus pediatric populations are also highlighted.

Durbin: *Tracheostomy is often performed in recovering critically ill patients to facilitate transfer from an intensive care environment. How long should a trach patient remain in a special care area before being transferred to a general floor?*

Cahill: Our practice is to transfer the patient after the physician completes the first trach change and the patient is stable medically.[1] Our transitional care center is designed especially for trach- and ventilator-dependent patients, so we don't require them to be weaned from mechanical ventilation before transferring.

White: Our pediatric institution designates 2 trach categories: critical trachs and all other fresh or newly revised trachs. The first category means the person is at significant risk of death if accidental decannulation were to occur, so they should remain in a special care area until the airway is deemed no longer critical.[2] All other trach patients could be transferred to a specialized floor where caregivers are trained to manage trachs. An RT should be readily accessible there to provide advanced airway management if needed.

Grooms: This is a good question because standards are lacking regarding the duration of necessary care for trach patients prior to ICU discharge, so specific independent risk factors associated with facility or ward mortality need to be evaluated. Examples include trach accompanied by a low Glasgow Coma Scale score (< 8),[3] body mass index less than 30 kg/m,[4,5] undernutrition,[6] the ability to clear respiratory secretions, and the reason for the trach.[7] The risks of common complications of trachs necessitate the need for specialized monitoring.[8]

Durbin: *That leads us to our next question. What monitoring is required for new trach patients when they are transferred to a general floor?*

Cahill: All our trach patients are monitored with a minimum of pulse oximetry and ECG during naps, procedures, and at night. In addition, I advocate that such patients have continuous $ETCO_2$ monitoring so staff can be notified more quickly if accidental decannulation were to occur.[9,10]

White: Heart rate and SPO_2 monitoring would quickly alert caregivers to an emergency airway situation.[11]

Grooms: Specialized monitoring on a general care floor should include pulse oximetry, telemetry, and capnography.[8]

Durbin: *What equipment should be available to new trach patients when they are transferred to a general floor?*

Cahill: A same-size trach tube, a size smaller trach tube, resuscitation bag, approximate-size face mask, scissors, lubricant, trach ties, suction, suction catheters and oxygen should be present at the head of the bed and also available for transport with the patient for any procedures within the hospital.

White: In addition to what Tom mentioned, we also include a stethoscope, sterile hemostats and saline bullets. All patients with new trachs should be given an emergency trach bag that is customized with all the supplies needed to manage the trach.[2,11,12] We give these to families to help educate them about trach care. The bags go home with the patient upon discharge.

Grooms: We provide similar equipment that follows trach patients on whatever floor they are transferred to.

Durbin: *One of the causes of mortality in patients with a fresh trach is accidental decannulation or trach tube malfunction. What can be done to mitigate the consequences of this in the ICU? In the general ward?*

Cahill: Prevention starts with recognizing high-risk patients, which includes infants and patients with altered mentation, then closing monitoring those patients. Continuous and remotely alerted $ETCO_2$ monitoring is useful in detecting accidental decannulations quicker than conventional ECG and SPO_2 and can help decrease mortality. Core team members including RTs, RNs, and MDs who are trained to respond to this type of emergency should consistently follow guidelines in place to mitigate problems.[9,10]

White: Checklists can help ensure patient safety. A patient with a fresh trach tube is a perfect example of a scenario where a checklist could be used successfully to ensure all emergency airway equipment is readily available,[13] along with emergency numbers of appropriate personnel to contact. All staff who are managing patients with a new trach tube should be trained and checked off on proper care of these patients.[11,14] A checklist could also be used when training caregivers to care for patients with trachs. Critical paths for care should be defined as well, because patient airway scenarios differ. For example, some instances where a dislodged trach would alert a critical emergency airway situation could include instructions to immediately call anesthesia or an ENT surgeon on call to the bedside. The care team for any patient with a critical airway should receive detailed instructions on how to handle all possibilities for emergency airway management.

Grooms: I agree that protocol-guided therapy for trach patients is important in both the ICU and general care milieus. This includes monitoring protocols, airway management protocols, ventilator libration protocols, and sedation protocols. Implementation of these can minimize unnecessary mechanical ventilator days.[15]

Durbin: *What methods do you use to prevent accidental extubation of a new trach?*

Cahill: We secure new trach tubes with strings for the first 7 days.[16] Typically sutures are placed in the eyelets to the neck to keep the trach tube from accidentally decannulating. Also, we place stay sutures in the cut edges of the trachea and mark right and left to allow a caregiver to hold the stoma open in case of accidental decannulation prior to the first change.[16]

White: We suture new trachs in and secure them with twill ties. The surgical team assesses the ties daily; sutures remain in place for 3 to 5 days. The surgical team does both the first tie and trach tube change at the pa-

tient's bedside within 5 to 7 days.

Grooms: We use sutures and a disposable, latex-free trach tube holder, which incorporates a soft, foam-padded cotton next wrap, accompanied by Velcro® straps, which attach easily to the trach tube neck flange. We prefer this type of tube holder to twill ties because twill can pose difficulties when inserted through the flange holes. Twill often tends to fray, leaving small threads that can migrate to the stoma and cause skin irritation. Trach holders with Velcro® tabs are convenient for the bedside caregiver and safe for the patient (figure 1.). The holders can be easily adjusted, accommodating neck circumference, couching, edema, and overall patient tolerance.

Durbin: *What should be done to reduce the incidence of VAP after tracheostomy?*

Cahill: Hand washing is the Number 1 way to prevent VAP.[17] Any other measure has minimal preventive effect if the caregivers don't user proper hand hygiene before starting trach care and oral care.

White: Absolutely. Regarding trach care, this includes covering the trach tube with either a trach collar or an HME or similar filter.

Grooms: The CDC recommends hand washing with soap and water, or user of an alcohol-based sanitizer that contains at least 60% alcohol before and after contact with patients.[18] Sterile technique is imperative for removing the trach dressing and inner cannula, as well as cleaning the skin, stoma and trach tube flanges. Ensuring the patient's head is raised 30 degrees is also a basic VAP preventive.[19]

Durbin: *Describe routine airway care of patients with a trach, including humidification options, suctioning, stoma care, and timing of the first and subsequent tube changes.*

Cahill: HMEs can protect the airway from larger foreign particulates but they aren't much use in preventing the introduction of bacteria or viruses. Suctioning should be done as needed or indicated—never scheduled or routine.[20] Stoma care twice daily and as needed will keep the stoma site clean. The physician should perform the first trach change at 1 week; that change has the highest risk of complications for the patient. Subsequent changes can be every 2 to 4 weeks as needed or as special needs dictate.[1]

White: Humidification is very important with trachs; it prevents plugging and drying of secretions. HMEs is 1 option to provide humidification. Regarding suctioning, routine oral suctioning should be done with routine oral care.[21] In our institution's VAP bundle, oral care is performed every 4 hours, along with draining the ventilator tubing, to prevent VAP.

> Twill often tends to fray, leaving small threads that can migrate to the stoma and cause skin irritation.
>
> - Grooms -

Grooms: Humidification is very important for keeping secretions liquefied. Although humidity is commonly administered with a cool-mist aerosol, we typically administer humidity through a high-flow system that uses heated molecular humidity, which may enhance mucociliary clearance. The use of heat moistures exchangers, or HMEs, versus heated humidification remains controversial—but recent evidence indicates a lower incidence of VAP in patients mechanically ventilated for more than 5 days with heated humidification.[22] The American Association of Respiratory Care offers several recommendations regarding suctioning.[23] Suctioning should be performed without ventilator disconnection, without routine use of saline instillation, and with closed systems. Open suctioning is performed typically when retained secretions are suspected. Oral care commonly includes use of an antiseptic agent to reduce oropharyngeal colonization.[24] The surgeon performs the first trach change 7 to 14 days after trach placement; a respiratory therapist performs subsequent changes, which could be anywhere from every 14 to 30 days.

Durbin: *Should the family or patient be taught and allowed to perform some routine care procedures such as tracheal suctioning?*

Cahill: Yes—as early as is possible, regardless of the anticipated decannulation date. This lets us observe the family and monitor the patient's safety for as long as possible. It also may facilitate an earlier date if long-term tracheostomy is indicated.[9]

Figure 1.

White: All caregivers, including families, should demonstrate knowledge and competency to perform routine trach tube and inner cannula changes, proper suctioning, and daily stoma care and cleaning. They also should be taught about potential complications from suctioning.[25] If the patient is able, he or she should also be taught self-trach management.

Grooms: I agree.

Durbin: *Describe how you determine weaning readiness. What steps do you take to remove a trach tube?*

Cahill: Weaning and decannulation decisions should be based on indicators such as air movement around the tube, capping trials, phonation, and activity. Patients who can phonate well, tolerate exercise and capping trials and have no clinical indication for the need of a trach are considered good candidates for decannulation.[26] Downsizing can reduce airway resistance and allow easier passage of airflow to the upper airways. Fenestration can accomplish the same thing, except it has the complication of granulation tissue forming into the fenestration, and you need to ensure the fenestration is in the correct position before and after insertion, as most fenestrated trachs do not account for patients with abnormal airway anatomy. I have no experience with the trach button, but my understanding is that it is a placeholder for the stoma site.

White: Weaning and decannulation happen much more rapidly in adult medical facilities compared to pediatric facilities such as ours. In pediatric patients, trach tubes are often placed because of airway anomalies and defects.[14] In those cases, as children grow or the airway is surgically repaired, the patient is often able to be decannulated.[27] That decision is often based on physician assessment of airway status.[12] We perform a large number of tracheal reconstructions at our institution. In those cases, after reconstruction, the trach is removed, and an endotracheal tube is placed.[27] The patient can often be extubated after the repair site and airway graft have healed.

Grooms: I think it's a "given" that weaning and decannulation practices vary.[28,29] However, most practices incorporate the assessment of patient tolerance during cuff deflation, cannula downsizing, speaking valves, and trach capping. Cuff deflation is commonly performed during spontaneous breathing. If successful for a specified duration, a speaking valve may be placed as tolerated. If a speaking valve is tolerated, downsizing

to a smaller trach is performed until decannulation. trach caps are often used in place of speaking valves and require complete cuff deflation.

Summary

Patients who have had tracheostomies require specialized monitoring and daily care to minimize the risk of VAP. Some patients will still be on mechanical ventilation when they are transferred from an intensive care unit to a general care unit. Such patients require monitoring and special equipment, including an emergency trach bag, to avert potential respiratory emergencies. In addition, caregivers on those respective units need to be trained in protocols and critical paths so they can deliver competent care and respond appropriately to a critical airway situation. Family members should be trained in daily trach care as soon as it is feasible, to help ensure the safety of patients who are discharged with long-term trachs. Decisions regarding weaning and decannulation vary among practitioners and patient populations, but the general process involves downsizing the trach until decannulation.References

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Ventilator-Associated Pneumonia and Tracheostomy— Continued from page 1

This may occur due to colonization of the biofilm that forms in and on the endotracheal tube and/or aspiration of pathogenic organisms around the endotracheal tube cuff. Proliferation of those organisms colonizes the trachea; and, in compromised patients, results in an invasive infection distally in the lung.[7] This progression is supported by many microbiological studies demonstrating that organisms associated with VAP first appear in oral secretions and gastric aspirates prior to being cultured from tracheal aspirates and bronchoscopies that confirmed VAP diagnosis.[8] In addition, a route of secondary infection from the lungs to the bloodstream with resultant septicemia may contribute to the high mortality observed in medical patients with VAP.[9]

VAP Diagnosis Dilemma

Confusion regarding the causes and impact of VAP arises because accurate diagnosis of VAP is difficult, and many conditions in critically ill patients can mimic signs of infections.[4] A clinical diagnosis of VAP is made when suspicion of the infection is high, confirmed by bacteriological methods.[1] Even with such confirmation, a definitive diagnosis may remain elusive.[10] Clinical scoring systems have been developed to grade the risk of a patient having VAP and to monitor treatment over time.[11]

Clinical suspicion of VAP includes a combination of the following: (1) a new or worsening pulmonary infiltrate, (2) a decline in oxygenation, (3) a new or worsening fever, and (4) a newly elevated white blood cell count with or without a shift to the left (increase in immature neutrophils, called "stabs"). Bacteriological confirmation requires tracheal or bronchoscopic cultures, semiquantitative cultures from protected catheter sampling, directed bronchoscopy, or cultures from broncho-alveolar lavage.[1] Treatment with broad-spectrum antibiotics directed toward the usual hospital-acquired pathogens should be started immediately when VAP is suspected.[12] If a patient has another known source of infection or positive results from previous tracheal cultures, the choice of agents should cover specific organisms identified. Care to prevent and identify antibiotic resistance is especially important in patients with a new or recurrent VAP,[13] as resistant organisms are associated with worse patient outcomes and higher mortality.[14,15] Delay of antibiotic administration if VAP is truly present is also associated with a worse clinical outcome.[16]

VAP Prevention

Numerous changes in clinical practices are associated with altering the VAP rate.[17] Counterintuitively, some care practices can do more harm than good. For example, manufacturer-recommended 24-hour ventilator

circuit changes actually increase the VAP rate compared to less frequent changes. Breaking the ventilator circuit for suctioning or medication administration also increases VAP rates; the use of inline suctioning devices may reduce it.

The Institute for Healthcare Improvement developed a "ventilator bundle," a set of 5 recommendations for reducing VAP rates: (1) elevate the head of the bed to at least 45° to reduce the incidence of gastric reflux (and thereby, pulmonary aspiration risk), (2) give daily "sedation vacations" and breathing trials to assess the readiness to extubate, (3) prevent peptic ulcer bleeding through GI prophylaxis, (4) prevent deep vein thrombosis using a blood thinner or mechanical compression device, and (5) use chlorhexidine as part of daily oral care.[18] Hospital reimbursement by insurers may soon be contingent on using and documenting these elements in all ventilated patients. Payment may be withheld for the additional costs of treating a VAP.[19,20]

Actions proven to lower VAP rates include healthcare workers' diligence to observe proper hand hygiene, specifically, hand sanitization and hand washing before and between contact with each patient.[21] Special endotracheal tubes (ETT) with a port above the cuff for removal of pooled, contaminated secretions have been demonstrated to reduce VAP rates and are recommended for prolonged intubation.[22] Lung protective ventilation (low tidal volume and low pressure ventilation),[23] conservative transfusion strategy,[24] and minimizing empirical use of broad-spectrum antibiotics are other interventions associated with a better pulmonary and patient outcomes.[25] Silver-impregnated ETTs can inhibit bacterial colonization and may lower VAP risk, clinical data supporting their use is emerging.[26]

If the major cause of VAP is the ETT bypassing the protection of the larynx and creating a passage from the oropharynx to the lung, then early removal of the tube should reduce VAP risk. This is supported by the fact that patients receiving non-invasive mechanical ventilation (NIMV) without an ETT have a lower VAP risk.[27] For patients requiring prolonged intubation (≥ 14 days), early tracheostomy (ET) may be useful for preventing VAP. This approach would remove the potential conduit to the larynx, allowing the laryngeal protective reflexes to recover and possibly reducing the VAP risk.

What Studies Say about tracheostomies and VAP Rates

The idea of placing a tracheostomy (trach) sooner than later to remove a potential portal for bacterial invasion seems logical, but it was met with resistance because early reports in the 1980s suggested that complications including lung infections were increased after placement of a trach. This led to recommendations that trach be considered only if an artificial airway was needed for 21 days or more.[28,29] However, it is important to remember that almost all patients who receive a trach do so following a variable period of time during which they are intubated with a conventional endotracheal through their larynx—the potential microbial conduit. Thus, the assumption that placement of a trach is the cause of a subsequent VAP is fallacious.

Thus, the assumption that placement of a trach is the cause of a subsequent VAP is fallacious.

Numerous observations, clinical trials, and other studies suggest that performing a trach earlier rather than later provides important patient and healthcare benefits. Most studies show that early tracheostomy is associated with a shorter ICU and hospital lengths of stay and may lower the risk of developing a VAP. Study results are mixed regarding whether early trach shortens weaning time or has any effect on mortality; however, other issues like increased patient comfort and using fewer healthcare resources[30,31] cannot be overlooked.

Strong support for the idea that an early trach could improve patient outcomes was provided by Rumbak and colleagues in 2004.[32] This prospective randomized trial compared early percutaneous dilational tracheotomy to prolonged translaryngeal intubation in 120 ICU patients predicted to need mechanical ventilation for more than 14 days. Patients were randomized to receive an "early" trach (ET) within 48 hours of ICU admission, or to receive a "late" trach (LT) on or after day 14. The patients had an average APACHE II score of 27.4, indicating an estimated death rate of around 55%. Remarkably, only 31.6% of the patients who received an early trach died, while 61.7% died in the LT group. Importantly, the difference in the incidence of VAP between the groups was marked: patients with ET had a 5% rate of VAP, while 25% of the LT group contracted VAP. VAP was believed to be the primary cause of death in 9 patients with LT but only 2 with ET (P>0.001). This was the first study to suggest improved survival with early rather than later trach. It was also a fairly large, well-controlled study that minimized confounders that could affect mortality and VAP rate, underscoring the importance of taking early trach seriously.

Another attempt to quantify the impact of tracheostomy on VAP rates was reported by Nseir and colleagues (2007).[33] Their case-controlled, retrospective study of 177 medical and surgical patients receiving tracheostomies matched patients on age, severity of illness on admission (APACHE II Score), admitting service (medicine or surgery), duration of mechanical ventilation, and duration of translaryngeal intubation before placing a trach. Their analysis demonstrated a lower VAP rate in the days following tracheostomy and confirmed that VAP rate increased with duration of translaryngeal intubation.[33] This analysis strongly supports the hypothesis that placement of a tracheostomy reduces the subsequent incidence of VAP.

In 2008, Scales and colleagues took a different approach to evaluating the effects of trach timing and mortality by examining large demographic databases and following patients for 12 years post discharge.[30] Their report, based on 10,927 adult patients who received a trach from 114 hospitals in Ontario, Canada, identified an increased risk of death for every day delay in providing a surgical airway. Mortality benefit persisted for at least a year following the procedure and after hospital discharge. One-third of the patients received an ET by day 10; the others, a LT (after day 10). Unadjusted mortality was slightly lower in the ET compared to the LT group at 90 days—but significantly lower at 1 year: 46.5% vs. 49.8%; P>0.001. Multivariant analyses using tracheostomy as a time-dependent variable showed that each additional delay of 1 day represented an increase in mortality equivalent to an increase in 90-day mortality from 36.2% to 37.6% per week of delay (relative risk increase 3.9%; number needed to treat: 71 patients to save 1 life per week delay). This is highly significant, due to the huge number of patients in the study. The effect was seen in every subgroup for every day over 10 days of mechanical ventilation, up to day 28 (the upper limit of the LT group as defined in the study). Quicker weaning in the ET group was noted also. Unfortunately, no data were available about VAP rates or detailed cause of mortality, so VAP's influence could not be determined in this study.

What Meta-analyses Say

Because large randomized studies of this topic are difficult to mount and statistically significant data may be seen more clearly in large samples such as the Scales study, meta-analyses of multiple (often smaller) studies can be used to see if there is "greater [statistical] strength in numbers." One such attempt was published by Griffiths and colleagues in 2006, which included medical and surgical patients from 5 randomized, controlled trials.[34] Griffith's conclusions stated that an early trach reduced ICU and hospital length of stay, but it had no significant effect on mortality or the development of VAP (although the trends in these areas were clearly in favor of early trach).[34] See Table 1

Table 1: **Studies included in Griffiths' meta-analysis**[34]

Study	Year	# of Patients	Patient Type	Early Trach (Days)	Late Trach (Days)
Bouderka et al[35]	2004	62	Head Injury	5–6	Continued ETT
Dunham et al[36]	1984	74	Trauma	3–4	14
Rodriguez et al[37]	1990	106	Surgical	1–7	8 or more
Rumbak et al[32]	2004	120	Medical	0–2	14–16
Saffle et al[38]	2002	44	Burn	Next OR day	14

for a list of the studies included. Heterogeneity of (1) patient populations, (2) inclusion criteria, (3) outcomes measurements, and (4) quality issues makes interpretation of these results challenging. In addition, the analysis included only 406 patients; selected studies used different definitions of early and late tracheostomy; some studies were not truly randomized, and the studies covered vastly different time periods and varying amounts of pertinent data.

In an attempt to reduce heterogeneity seen in the previous analyses, Durbin and colleagues performed a meta-analysis of truly randomized studies in which the ET group received a trach within 5 days of intubation.[31] There was a clear mortality benefit of early tracheostomy and a trend to low VAP in this cohort of patients. Earlier trach could reduce the amount but not eliminate microaspiration into the lung around the cuff of the endotracheal tube.

Effects of Early trachs on Surgical and Trauma Patients

Table 1 hints at a potential confounder in comparing early trach outcomes across various sub-populations of ICU patients. Although trauma has been identified as an independent predictor for developing VAP,[39] surgery/trauma patients seem to fare differently from medical patients with respect to early trachs. A 2006 meta-analysis of trauma patients by Dunham and Ransom, which included 4 RCTs and 5 retrospective analyses, said that early tracheostomy conferred no benefit at all: no difference in mortality, VAP rate, ICU length of stay, or hospital length of stay; however, no worsening outcomes were seen, either.[40] The only patient subgroup in this analysis that showed a definitive benefit was patients with severe head injuries. An earlier trach in that subgroup led to a shorter length of ICU stay.

In a large cohort study in a single institution, patients with severe CHI experienced important benefits from ET. Between 2004 and 2007, a total of 2,481 patients with head injury were treated in a specialized neurosurgical ICU.[41] Sixty-six of those patients underwent tracheostomy, 16 within 10 days of the start of mechanical ventilation and 50 after day 10. Timing of the tracheostomy was not by protocol, but the groups were fairly well matched in demographics including and the type and severity of injury at presentation, Glasgow Coma Scale, Injury Severity Score, age, sequential organ failure score, and coexisting chronic conditions. The ET group had shorter ICU and hospital lengths of stay, as well as fewer cases of VAP (ET = 54% and LT = 70%) and fewer days of antibiotic treatment. Similar to studies discussed earlier, there was no difference in mortality, which was remarkably low in both groups (ET= 12% and LT= 8%). Other studies have identified benefits of an early tracheostomy in spinal cord injured and severely head injured patients, including a reduction in VAP rate.[35,42,43,44]

Because surgical patients have lower rates of VAP compared to medical patients, the effect of ET on VAP rate may be more difficult to demonstrate in those patients. However, a 2005 retrospective study by Möller of 158 surgical ICU patients receiving a trach less than 7 days after ICU admission demonstrated a significant benefit over later tracheostomy.[45] Using logistic regression analyses, the authors demonstrated that the earlier the trach was performed, the less VAP developed compared to patients receiving a trach after day 7. All 5 regression analyses showed that the only significant predictor of VAP was the time to trach. The odds ratios as tracheostomy is delayed by each additional day are shown in Table 2. Additionally, when ET was compared to LT, the incidence of VAP was only 27% in the ET group; in contrast, it was 42% in the LT group. No difference in mortality was seen, but ICU and hospital lengths of stay were longer in the LT group.

Summary

VAP is commonly identified in intubated patients receiving mechanical ventilation. VAP is associated with longer ICU and hospital stays and higher overall cost of care. In medical patients, VAP is associated with increased mortality, and some of those deaths are due to lung infection. Most studies suggest that surgical and trauma patients who develop VAP have longer treatment courses but seem to suffer less increase in mortality as a result. Many changes in practice have been shown to decrease the incidence of VAP. Performing a needed tracheostomy as early as possible removes 1 route of lower airway contamination, decreasing, but not eliminating the risk of VAP. No reported study of tracheostomy timing has demonstrated a worse mortality or higher costs with ET. The size and quality of studies reported to date are inadequate to mandate that trach must be performed before a specific day (7 or 10); but the preponderance of evidence suggests that "the earlier the better" can help prevent VAP and increase survival.

Table 2: **Odds ratios of developing VAP for each day of delay in performing early tracheostomy (Möller study)**[45]

Cut Point (days after ICU admission when trach done)	Odds	95% Confidence Interval
3 days	3.9	1.2-12
4 days	3.0	1.3-7.0
5 days	3.0	1.4-6.5
6 days	2.7	1.3-5.5
7 days	2.3	1.2-4.4

An odds ratio of 1 would mean that an event is equally likely in both groups. On all days listed, the odds for developing VAP were significantly higher in the LT group.

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After reading this article, the learner should be able to:

1. Discuss the different impact that early versus late tracheostomy has on outcomes on medical compared to surgical/trauma patients.
2. List 4 reasons that a study may not show improved outcomes with early versus later tracheostomy.
3. List the elements of the "ventilator bundle" and suggest at least three other clinician actions that can influence the development of VAP.

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1. **Which of the following is NOT a component of the Ventilator Bundle?**
   a. Frequent patient position changes to prevent atelectasis.
   b. GI bleeding prophylaxis.
   c. Elevation of the head of the bed to 45 degrees.
   d. Deep vein thrombosis prophylaxis.
2. **Which of the following is most correct about medical patients requiring mechanical ventilation?**
   a. Medical patients have a lower incidence of VAP than surgical patients.
   b. Medical patients managed with non-invasive ventilation have a lower risk of VAP than those intubated.
   c. tracheostomy is contraindicated in COPD patients.
   d. Late tracheostomy is favored since it will allow terminal patients to be identified, sparing them prolonged ventilation prior to death.
3. **Which of the following is necessary to suspect that VAP is present?**
   a. A high white blood cell count with a left shift.
   b. A positive blood culture.
   c. A new or higher fever.
   d. None of the above are necessary.
4. **Early tracheostomy is defined:**
   a. as a tracheostomy as soon as possible after intubation.
   b. differently in different studies.
   c. within 10 days of ICU admission.
   d. within 7 days of translaryngeal intubation.
5. **One of the unequivocal patient benefits of tracheostomy is**
   a. Increased patient safety.
   b. Shorter length of stay in the ICU.
   c. Shorter time to wean from mechanical ventilation.
   d. None of the above.
6. **Patients with severe head injury requiring intubation should**
   a. have a late tracheostomy because many will die from their injury before needing a trach.
   b. have an early tracheostomy because it can shorten ICU stay.
   c. be managed with an oral endotracheal tube only because of a low rate of VAP
   d. be managed only with a nasal endotracheal tube because it is more stable and safer.
7. **Late onset VAP**
   a. Is more difficult to treat due to changes in types of pathogenic organisms
   b. Is more common if tracheostomy is delayed beyond 7 days.
   c. Is more likely to be due to highly resistant organisms.
   d. all of the above are true.
8. **With regard to early tracheostomy, large demographic database analysis suggests**
   a. every day a tracheostomy is delayed significantly increases mortality.
   b. mortality is similar with early or late trach following ICU discharge.
   c. there is no difference at 90 days and 1 year in group mortality.
   d. More ill patients receive early tracheostomy because they are identified sooner as needing a trach.
9. **Accidental extubation of the trachesotomy tube can be prevented by:**
   a. Suturing
   b. Twill ties
   c. Manufactured trach tube holder with Velcro® straps
   d. All of the above
10. **What procedure can be taken to prevent VAP after a tracheostomy?**
    a. Hand washing
    b. Covering the trach with a cover of an HME
    c. Sterile technique for removing trach dressing and inner cannula
    d. All of the above

Participant's Evaluation

What is the highest degree you have earned (circle one) ? 1. Diploma 2. Associate 3. Bachelor's 4. Master's 5. Doctorate

Indicate to what degree you met the objectives for this program: Using 1 = strongly disagree to 6 = strongly agree rating scale. Please circle the number that best reflects the extent of your agreement to each statement.

	Strongly Disagree					Strongly Agree
1. Discuss the different impact that early versus late tracheostomy has on outcomes on medical compared to surgical/trauma patients.	1	2	3	4	5	6
2. List 4 reasons that a study may not show improved outcomes with early versus later tracheostomy.	1	2	3	4	5	6
3. List the elements of the "ventilator bundle" and suggest at least 3 other clinician actions that can influence the development of VAP.	1	2	3	4	5	6
4. The content of this course was presented without any bias of any product or drug.	1	2	3	4	5	6

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4	☐	☐	☐	☐
5	☐	☐	☐	☐
6	☐	☐	☐	☐
7	☐	☐	☐	☐
8	☐	☐	☐	☐
9	☐	☐	☐	☐
10	☐	☐	☐	☐
11	☐	☐	☐	☐
12	☐	☐	☐	☐
13	☐	☐	☐	☐
14	☐	☐	☐	☐
15	☐	☐	☐	☐
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Vol. 9, No. 3 /10